



Palaeoclimatic Significance of Fungal Remains from Marine Green Shales of the Naredi Cliff Section (Early Eocene), Kutch, Gujarat, India

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Abstract

Fungal remains are recorded from the marine green shales of the Early Eocene Naredi cliff section, Kutch, Gujarat, India. The following genera have been documented: *Phragmothyrites eocaenica*, *Monoporisporites konenigio*, Microthyriaceous germings, *Multicellaesporites* sp. and other fungal remains. The fungal remains suggest that the warm humid tropical climate was prevailing at the time of deposition of green shales. The presence of *Acarinina* (Foraminifera) in marine green shales suggests warm water conditions during the deposition of green shales. Our study suggests that both land as well as sea were relatively warmer during the Early Eocene time.

Keywords: Fungal remains, Climate, Naredi, Early Eocene, Gujarat, India.

Introduction

During palynological investigation of samples from the Early Eocene Naredi cliff section, Kutch some fungi remains were encountered. In view of the usefulness of fungal remains as a palaeoclimate proxy, we made taxonomic and paleoecological studies of these fungal remains from the Naredi cliff section. The Early Eocene Naredi Cliff sediments, belonging to Naredi Formation are exposed along channel in Naredi type locality region (**Fig. 1; Fig. 2**) (23°39'49"~68°40'38", Biswas, 1992), Southwestern Kutch. Biswas (1992) subdivided Naredi Formation sediments into three main members: lower most Gypsiferous Shale Member at

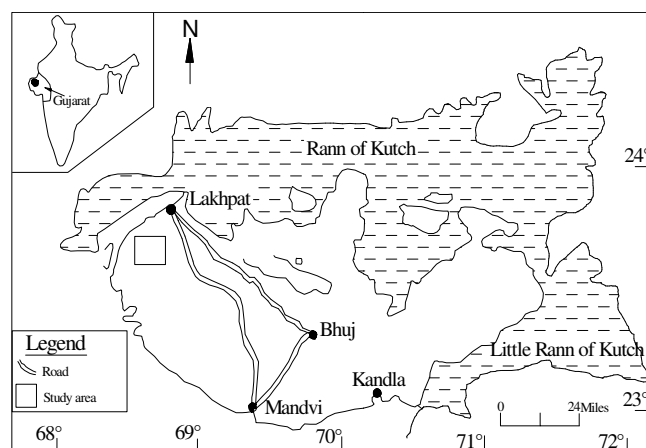


Fig. 1. Location of study area

the base with grey, brown and olive green glauconitic claystones and shales, including

gypsum, limonite and siderite concretions; middle *Assilina* Limestone Member of bedded limestone and yellow-grey marls rich in *Assilina* shells; upper Ferruginous Claystone Member at the top with grey-brown iron-rich claystone. Earlier studies on palynology of these sediments have been done by Venkatachala and Kar (1969), Sah and Kar (1969, 1970), Kar (1978) and Kar and Saxena (1976). This work focuses on fungal remains from the Naredi cliff section to decipher the palaeoclimatic conditions prevailing during the Early Eocene in Kutch.

Materials and Methods

Detailed lithologic logs were prepared for the exposed section the Kakdi River channel bank. Fresh samples were collected from the exposed section for palynological processing. For the recovery of microfossils samples were subjected to standard palynological processing techniques (HCL, HF, HNO₃ and KOH). The retrieved organic matter was dispersed in polyvinyl alcohol, smeared on cover slips, dried and mounted on glass slides by Canada balsam. About 5 slides of each sample have been prepared for the study. All slides are preserved in Department of Geology, Nagpur University. For fungal remains, the terminologies of Dilcher (1965) and Elsik (1968, 1976) has been used.

Results

The palynoflora from the Naredi cliff section marine sediments contains spores, pollens, fungal spores and dinoflagellates. The fungal remains present in the samples are *Phragmothyrites eocaenica*, *Monoporisporites konenigio*, Microthyriaceous germlings, *Multicellaesporites* sp. and other fungal remains.

Genus: *Monoporisporites* Van der Hammen 1954

Type species: *Monoporisporites minutus* van der Hammen 1954

Monoporisporites konenigio Elsik 1968

Plate 1.1

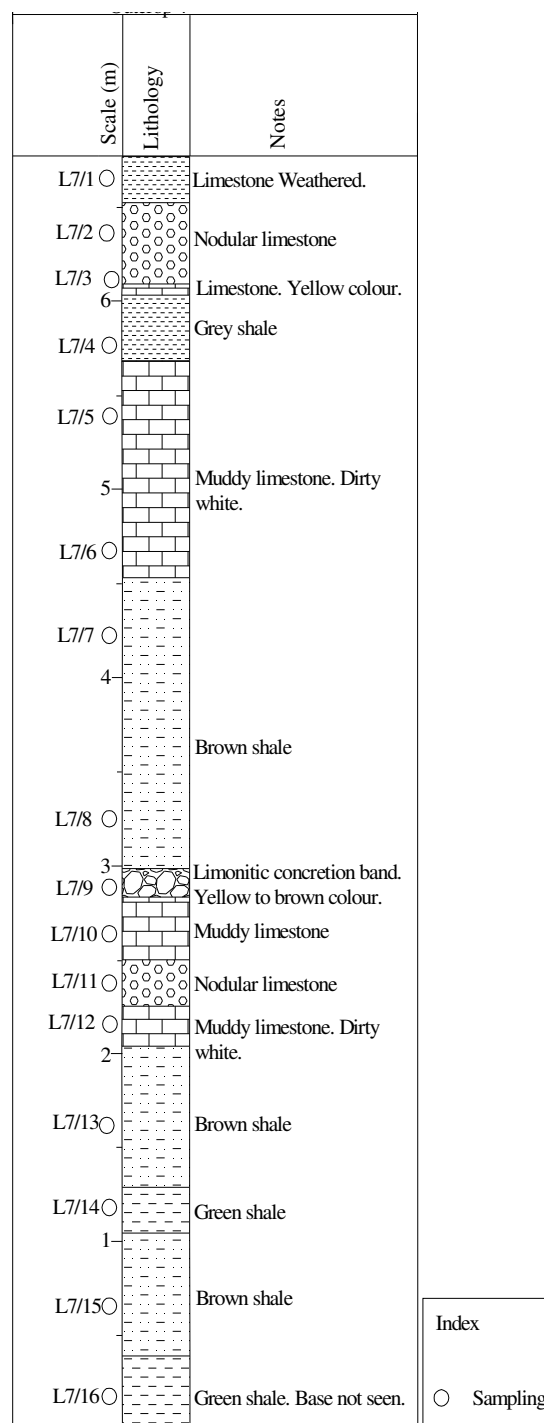


Fig. 2. Litholog of Naredi cliff section

Description: Subspherical to pear shaped, psilate, monoporate fungal spores, spore walls generally darkly pigmented, spore wall turned into the pore.

Remarks: The described morphotype is similar to *M. konenigio* described by Elsik (1968).

Genus: Microthyriaceous germlings Dilcher 1965

Type species: Microthyriaceous germlings Dilcher 1965

Plate 1.2

Description: Fungal bodies with lenticular to convolute multi-lobed margins. They are probably germlings showing a number of developmental stages of Microthyriaceous germlings (Dilcher, 1965).

Remarks: From Eocene leaf deposits in Tennessee, Dilcher (1965) described and illustrated growth stages in fossil fungi referable to the family Microthyriaceae. Similar growth stages of ascostromata are present in sample from Naredi. The known stratigraphic range for such remains is early Eocene to the Present.

Affinity: Microthyriaceae

Genus: Multicellaesporites (Elsik) Sheffy and Dilcher 1971

Multicellaesporites sp.

Plate 1.3

Description: Fungal spores oval in shape; generally dicellate rarely tricellate, 15-17×18-21 µm in size, both the cells equal in size, individual cell circular and about 9 µm in diameter, cells slightly overlapping each other and hyaline; spore wall <1 µm thick; smooth.

Remarks: *Multicellaesporites elsikii* Kar and Saxena, 1976 is tetra to pentacellate and elliptical in shape. *M. prakashii* Ambwani, 1982 is tetracellate. Presence of 2-3 cells of distinctly circular shape is the diagnostic characters of this sporomorph.

Genus: Phragmothyrites Edwards 1922

Type species: *Phragmothyrites eocaenica* Edwards 1922

Phragmothyrites eocaenica Edwards 1922

Plate 1.4

Description: Ascostroma generally circular to subcircular, 48-85 µm in size, non-ostiolate; no free hyphae, hyphae radially arranged and interconnected with each other to form mostly one celled thick pseudoparenchymatous cells, cells non-porate, radially elongated, cell wall more or less uniformly thick throughout or marginal cells thicker, porate.

Remarks: The genus *Phragmothyrites* includes circular to subcircular, non-osteolate, radiate and dimidiate fructifications with pseudoparenchymatous body and without free mycelium.

Affinity: Microthyriaceae

Discussion

Many workers (Reddy et al. 1982; Cookson, 1947; Selkirk, 1975; Lange, 1976, 1978) have highlighted the importance of fungal remains in palaeoclimatic interpretation. The epiphyllous fungi mainly Microthyriaceae are good indicator of climate, as for their heavy rainfall is essential (Cookson, 1947; Selkirk, 1975; Reddy et al. 1982). The occurrence of epiphyllous fungi such as *Phragmothyrites* and *Trichothyrites* indicates heavy rainfall at the time of deposition. The presence of such fungi in the assemblage suggests humid climatic conditions. Apart from fungal remains, presence of pollen taxa which are affiliated to distinctly tropical families, such as Bombacaceae, Gunneraceae, Sapotaceae, Ctenolophonaceae, Proteaceae and Olacaceae also suggest tropical climatic conditions at the time of deposition.

Fungi are found in close association with specific plants and animals and if found in a fossil state are indicative of similar kind of situations during the geological past. Fossil fungi therefore, may provide useful information about the palaeoecology, past habitats and their hosts. In this regard fossil epiphyllous fungi can be more reliable and advantageous for palaeoclimatic interpretations. Occurrence of these fossils reflects moist and humid climate of tropical to subtropical belts (Prasad, 1986). The fossil peltate fungi are generally identified to the extant Microthyriaceae which are ectoparasites on leaves of higher plants of tropical to subtropical zones growing particularly in areas with high humidity. Edwards (1922) reported the occurrence of this group on conifer needles. Microthyriaceous fungi grow best in rain forests, rain forest margins and along creek banks (Ramanujam, 1982). Hence their presence is generally indicative of a wet tropical climate with heavy precipitation. The palaeohabitat interpretations based on fossil epiphyllous Microthyriaceous fungi and their germlings is well-established through the studies on their modern equivalents growing on leaf litter from various Australian regions. These studies have shown the occurrence of Microthyriaceous germlings in greater number on the plants growing in moist tropical habitats.

Modern epiphyllous fungi are encountered in areas characterized by humid climate and fairly stable temperature throughout the year (Schmiedeknecht, 1995; Hofmann, 2010; Kumar et al. 2011; Piepenbring et al. 2011). Most important for their growth are wet climatic conditions such as high annual rainfall and high air moisture (Selkirk, 1975; Johnson & Sutton, 2000; Limaye et al. 2007). Earlier studies reported the common occurrence of *Nummulites*, *Rotalia*, *Cibicides*, *Asterigerina*,

Bolivina and planktonic foraminifers *Acarinina*, *Chiloguembelina* and *Jenkinsina* (Sarkar et al. 2012). Khozyem et al. (2013) in their study on Lower and Middle Members of Naredi Formation reported presence of *Acarinina esnaensis* and *Acarinina quetra*. The presence of *Acarinina* suggests warm water conditions during the deposition, as *Acarinina* were specialized surface water dwellers with a preference for warm water (Boersma & Premoli-Silva, 1983; Olsson et al. 1999; Pearson et al. 2001; Sexton, 2005; Luciani et al. 2007). *Acarinina* suggests warm water conditions during the deposition.

Conclusions

The presence of fungal remains genera and species like *Phragmothyrites eocaenica*, *Monoporisorites konenigio*, Microthyriaceous germlings, and *Multicellaesporites* sp. has been documented from the marine green shales of the Naredi cliff section of Kutch region. The fungal remains suggest that the warm humid tropical climate was prevailing at the time of deposition of these green shales. The occurrence of *Acarinina* (Foraminifera) from marine green shales suggests warmer ocean water conditions during the deposition, as *Acarinina* were specialized surface water dwellers with a preference for warm water. Our correlative study using fungal remains and integrating foraminifera data from marine green shales of Naredi cliff section suggests that both land as well as sea were relatively warmer during the Early Eocene time.

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Plate 1. Explanation of photographs (All magnification ×40)

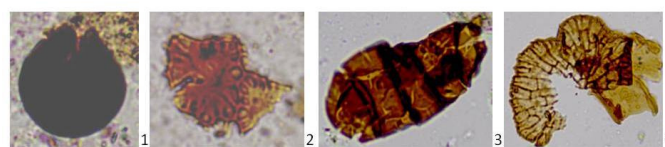


Plate 1.1. *Monoporisporites konenigii* 2. Microthyriaceous germlings 3. *Multicellaesporites* sp. 4. *Phragmothyrites eocaenica*

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